3.—The Flora of Granite Rocks of the Porongurup Range, South Western Australia

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The occurrence of the vascular and non-vascular flora on granite outcrops of the Porongurup Range in south Western Australia is described in relation to the environment. A systematic list of the algal, lichen, bryophyte, pteridophyte an angiosperm species of this flora is given.

Introduction

The Porongurup Range,† twelve miles east of the town of Mount Barker, consists of granitic rocks rising from the surrounding plain to a maximum altitude of 2,200 feet at the peak known as the Devil's Slide. Other peaks in the range include Castle Rock (altitude 1,870 feet), Twin Peak East (2,080 feet), Twin Peak West (2,040 feet), Gibraltar Rock (2,100 feet), Nancy's Peak (2,140 feet), Hayward Park Peak (2,000 feet), Angwin Park Peak (1,780 feet) and Collier Park Peak (2,080 feet).

The vegetation type of the range is an outlier of the Karri forest to the west. The trees include Karri, *Eucalyptus diversicolor*, the Marri, *E. calophylla* and to a less extent, *E. cornuta* and *E. megacarpa*. The under-storey of this forest includes the tall shrubs, *Trymalium spathulatum*, *Acacia pentadenia*, *Albizzia distachya*, *Oxylobium lanceolatum*, *Mirbelia dilatata* and numerous species of smaller sclerophyllous shrubs.

This paper describes the flora of granite outcrops in this forest. Collections and observations were made at Castle Rock, Nancy's Peak, Devil's Slide, Gibraltar Rock and at several outcrops towards the base of the range.

One large slope about 80 feet above the Bolganup Dam (988 feet) has been called by the author, Rain Gauge Rock, after the automatic rain gauge set up on it since 1957 by the Hydraulics Branch of the Country Water Supply Department in connection with the Bolganup Dam.

Climatic Data

Rainfall

The existence of an automatic rain gauge at Rain Gauge Rock provides some evidence of the amount and monthly distribution of precipitation on the site of some of the lithophyllous communities described below. Table I shows the annual rainfall for three consecutive years as taken from August, 1957, when the gauge was set up.

TABLE I

Annual rainfall for three consecutive years at Rain Gauge Rock (Bolganup Dam) Porongurup Range, Western Australia

Year	Rainfall in Inches
August, 1957-1958	20.16
August, 1958-1959	29.91
August, 1959-1960	52.03
Average Annual Rainfall	34.03

The average yearly rainfall for the nearby town of Mount Barker is 30.23 inches and that of Albany to the south of the Porongurups is 39.67 inches. A study of rainfall isohyets for this region indicates that the normal annual rainfall at the Porongurups could be about 34 inches, as both Mount Barker and the Porongurups are between the 30 inch and 40 inch isohyets, but much closer to the former.

An analysis of the monthly rainfall at Rain Gauge Rock into total winter and summer precipitation gives some idea of the seasonal desiccation to which the lithophyllous communities are subjected. In Table II the winter rainfall is taken as a six month period from May, when the winter rains start, to the end of October, and the summer rainfall as the precipitation from November to the end of April. The table shows that the lithophyllous communities are subjected to a wet half and a relatively dry half of the year. This evidence of summer desiccation supports the general climatic picture in the south-west of Western Australia where shallow-rooted plant communities are subjected to drought from about November to April.

TABLE II

Winter and summer rainfall at Rain Gauge Rock (Bolganup Dam), Porongurup Range, Western Australia

Winter rainfall in inches. May 1st-Oct. 31st	Summer rainfall in inches. Nov. 1st-April 30th
At Rain Gauge Rock	
22.59 (1958)	3.75 (1957-58)
23.56 (1959)	8.78 (1958-59)
27.05 (1960)	16.62 (1959-60)
Mt. Barker (Average)	
21.75	8.48

Temperature

The yearly average of daily maximum temperature for Mount Barker is 67.7° F, the monthly average of daily maximum temperature being greatest in February at 78.3° F. At Mount Barker the average of daily minimum

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† Although commonly written Porongorup, the name Porongurup was given by Surveyor-General J. S. Roe in 1835, and is followed by the Geographic Nomenclature Committee.

temperature is 48.3° F. the monthly average of minimum temperature being lowest in July at 42.0° F. These figures give some indication of the temperature extremes likely to obtain at the Porongurups, where unfortunately there is no recording station. The climatic data for Albany and Mount Barker were taken from Climatic Averages of Australia—Bureau of Meteorology, Melbourne, 1956.

Flora on the Granite Outcrops

The lithophyllous flora of granite rocks in south Western Australia is composed chiefly of bryophytes, lichens and sub-aerial algae. Small herbaceous vascular plants are also common in moss swards on granite slopes, while larger, perennial vascular plants are limited to the humus-filled crevices and depressions, or to the shallow soil at the border of outcrops.

The bryophytes and lichens of south Western Australia are reasonably well-known systematically from early collections made by visiting botanists, but there are few published records of these plants in relation to their habitats. Diels (1906), in his account of the vegetation of south Western Australia, did not describe the cryptogamic flora of rock outcrops. Likewise, Gardner (1942) described only the vascular flora in very general terms. Willis (1953), in his descriptions and analysis of the land flora of the Archipelago of the Recherche gave considerable ecological information on the lithophyllous flora of the igneous rocks of these islands. This flora shows some affinities with the lithophytes of the Porongurup Range, such as the wide occurrence in the Recherche of the mosses *Campylopus bicolor* and *Bryum billardieri*, and of the lichens, *Parmelia rutidota* and *P. conspersa*. The two floras differ strikingly, however, in the paucity of *Cladonia* species at the Recherche, whereas four species of this genus are common components of moss swards at the Porongurup Range. On the other hand the cushion plant, *Borya nitida* is common on granite slopes of the Recherche as it is on granite rocks of the Darling Range near Perth, but is conspicuous by its absence in the Porongurup Range.

Crustose Algal and Lichen Communities

The surfaces of granite tors and other steeply sloping outcrops which, to the casual observer, are bare rock surfaces, bear extensive communities of minute crustaceous lichens and blue green algae (Plate II, Fig. 2).

This type of community consists of the crustose lichen, *Caloplaca aurantiaca* and at least five other species of crustose lichens which to date it has not been possible to determine. The sub-aerial algae, *Calothrix sp.* and *Chroococcus sp.* occur in black, stain-like stands, mainly along seepage depressions over the outcrops.

The more conspicuous lichens, *Parmelia rutidota, P. imitatrix, P. conspersa, P. perlata* and *Sticta crocata*, also occur on steep rock faces whether exposed to full sunlight or partially shaded by the canopy of the Karri forest (Plate I, Fig. 1). *Sticta* appears to reach maximum vegetative development on gentle semi-shaded slopes where water seepage is high.

The moss, *Grimmia trichophylla*, is the only bryophyte found on the summits of granite tors and domes where it grows in small cushions in depressions and crevices resulting from weathering of the rock.

Moss Sward Communities

Low angled granite slopes throughout the Porongurup Range bear extensive moss swards which form mosaics with encrusting algal communities or crustose lichen communities (Plate I, Fig. 1 and Plate II, Fig. 1). Rarely is much of the rock surface devoid of plant life. Where recent exfoliation of the rock has occurred this is so, of course.

The association of species in these moss swards is variable but from examination and sampling of numerous slopes up to an angle of approximately 45° and of varying exposures to all points of the compass, but not shaded by trees or shrubs, the following species assessment may be given.

Two mosses, *Campylopus bicolor* and *Breutelia affinis* are the most extensive sward components. Other mosses in this sward include *Sematophyllum homomallum, Rhacocarpus humboldtii, Bryum argenteum, B. billardieri, Tortella calycina, Hedwigia imberbis.* The sward rarely exceeds three inches in depth where it overlies fairly smooth granite slopes and its surface is remarkably even considering the several moss components.

The high water-holding capacity of the mosses enables several herbs and geophytes to colonise the sward. The chief vascular plants are:—

Ophioglossum coriaceum
Triglochin centrocarpa
Aira caryophyllea
Brizula muelleri
Centrolepis glabra
Pritzelia pygmaea
Bulbine semibarbata
Chamaescilla corymbosa
Tribonanthes variabilis
Hypoxis glabella
H. occidentalis
Pterostylis nana
Calandrinia pygmaea
C. calyptrata
Spergularia rubra
Drosera glanduligera
Crassula pedicellosa
C. macrantha
C. sieberiana
Trifolium dubium
Hydrocotyle callicarpa
H. diantha
H. blepharocarpa
Trachymene pilosa
T. anisocarpa
Homalosciadium verticillatum
Anagallis femina
Mitrasacme paradoxa
Erythraea australis
Bartsia latifolia
Stylidium calcaratum
S. corymbosum var. *proliferum*
Veronica calycinus
Polypompholyx tenella
Galium murale
Levenhookia dubia
Rutidosis multiflorus
Helipterum cotula
Angianthus tenellus
A. humifusus
Quinetia urvillei
Cenia turbinata
Hypochoeris glabra
Podolepis lessonii

1

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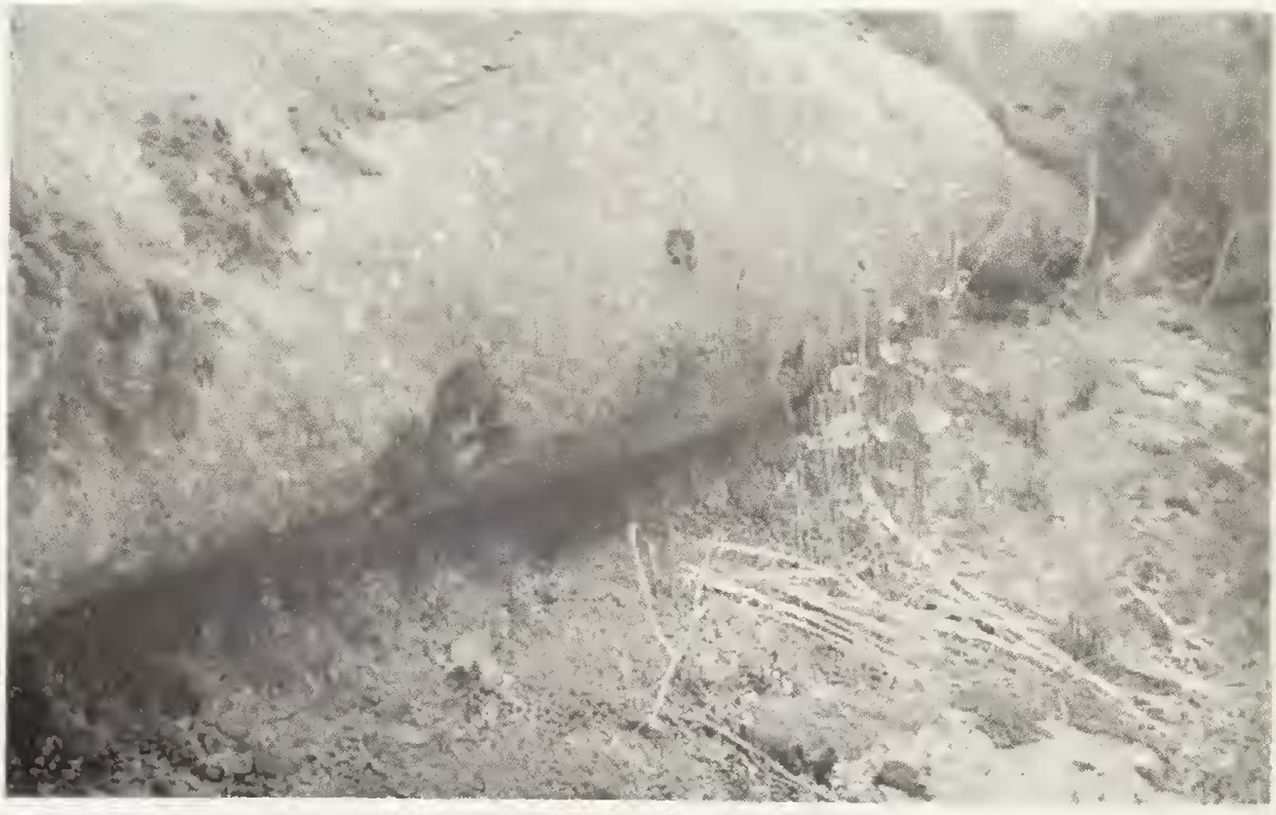

PLATE I

Fig. 1.—Moss sward over granite with *Trachymene anisocarpa* in flower and *Pelargonium drummondii*. Granite surfaee in the background with *Parmelia rutidota*. The shrubbery in the right background consists of *Thryptomene saxicola* and *Stypandra grandiflora*.

Fig. 2.—Granite boulder with *Veronica calycina* in shaded recess. Right foreground with moss sward and *Villarsia ealthifolia* in flower.

1

2

PLATE II

Fig. 1.—Moss sward on granite slopes with *Pelargonium drummondii*, *Cheilanthes tenuifolia* in centre and background, *Thryptomene saxicola* and *Stypandra grandiflora* shrubbery towards edge of slope. *Eucalyptus diversicolor* and *E. calophylla* in the background.

Fig. 2.—Moss sward on granite slopes. Slopes and boulders with crustose lichens. *Pelargonium drummondii* amongst boulders. *Acacia* sp., *Lepidosperma effusum* and *Thryptomene saxicola* in background.

The lichen component of the sward includes the foliose forms, *Cladonia furcata, C. aggregata, C. chlorophaca, C. retipora, Siphula caesia, Sticta crocata* and *Collema* sp. These lichens grow embedded in the moss turf, but *Siphula* also grows in pure stands in exposed humus of shallow rock crevices. The only liverwort collected from the sward was *Fimbriaria conocephala*.

A few species of perennial vascular plants occur on granite slopes where either a crevice or the moss sward over depressions provides sufficient depth of humus for their root systems (Plate I, Fig. 1 and Plate II, Figs. 1 and 2). The fern, *Cheilanthes tenuifolia* occurs in extensive stands in the deeper parts of the moss swards. *Stypandra grandiflora, Pelargonium drummondii, Carpobrotus aequilaterus, Geranium pilosum, Lepidosperma effusum, Thryptomene saxicola, Darwinia citriodora* and *Agonis juniperina* are conspicuous perennials of the shrubbery of these crevices and depressions.

Communities of Shaded Crevices

Along the ridge of the Porongurup Range the exposed granite core of the range forms a massive system of tors with numerous deep crevasses and shallow caverns or recesses resulting from the sphaeroidal weathering of the granite. In these dissections, leaf litter and the products of exfoliation accumulate to form a shallow loam. Wherever this loam is sufficiently shaded by the adjacent rock a distinctive microflora develops (Plate I, Fig. 2).

The principal bryophyte and lichen elements of this microflora are *Lophocolea heterophylloides* and *Lepidozia parvistipa*, both of which form extensive mats over either loam or granite substrates. *Frullania latogaleata* is common in drainage depressions of the overhanging rock. *Sematophyllum homomallum* forms extensive mats. *Sticta crocata* is most common in shaded exfoliation depressions. *Marchantia cephaloscypha* is a rare but striking liverwort on humus of shaded undercuts.

Commonly associated with these bryophytes and lichens in the recesses of rock dissections are the ferns, *Asplenium flabellifolium*, *Adiantum aethiopicum* and *Anogramma leptophylla*, the latter invariably accompanied by large numbers of its long-lived prothalli. *Asplenium praemorsum* occurs in more exposed crevices, although this fern is not common in the Porongurup Range.

The most common angiosperms in this habitat are *Corybas dilatatus, Cryptostylis ovata, Poa caespitosa, Pelargonium drummondii, Oxalis corniculata, Hydrocotyle hirta, Villarsia calthifolia* (a handsome species endemic to the Porongurup Range) and *Veronica calycina* (Plate I, Fig. 2). In rock dissections of more open aspect the following shrubs are common:— *Thryptomene saxicola, Sollya fusiformis, Stypandra grandiflora* and *Solanum nigrum*.

Systematic List of the Flora on Granite Outcrops of the Porongurup Range

Specimens of the following species are preserved in the Herbarium of the Botany Department of the University of Western Australia.

Algae

Chroococcaceae
Chroococcus sp.

Rivulariaceae
Calothrix sp.

Bryophyta-Hepaticae

Lepidoziaceae
Lepidozia parvistipa Tayl.

Harpanthaceae
Lophocolea heterophylloides Nees

Frullaniaceae
Frullania latogaleata Herz.

Marchantiaceae
Marchantia cephaloscypha Steph.

Operculatae
Fimbriaria conoccphala Steph.

Bryophyta-Musci

Grimmiaceae
Grimmia trichophylla Grev.

Dicranaceae
Campylopus bicolor (Hornsch.) Hook.f.

Pottiaceae
Tortella calycina (Schwgr.) Dixon

Bryaceae
Bryum argenteum Hedw.
B. billardieri Schwgr.

Bartramiaceae
Breutelia affinis (Hook.) Mitt.

Hedwigiaceae
Hedwigia imberbis (Sm.) Spreng.
Rhacocarpus humboldtii (Hook.) Lindb.

Sematophyllaceae
Sematophyllum homomallum (Hpe.) Broth.

Lichenes

Collemaceae
Collema sp.

Stictaceae
Sticta crocata (L.) Ach.

Cladoniaceae
Cladonia furcata (Huds.) Schrad.
C. aggregata (Sw.) Eschw.
C. chlorophaea (Flk.) Spreng.
C. retipora (Labill.) Fries

Parmeliaceae
Parmelia rutidota Hook.f. and Tayl.
P. imitatrix Tayl.
P. conspersa Ach.
P. perlata (L.) Ach.

Usneaceae
Siphula caesia Muell. Arg.

Caloplacaceae
Caloplaca aurantiaca (Lightf.) Fries

Pteridophyta

Ophioglossaceae
Ophioglossum coriaceum A. Cunn.

Pteridaceae
Cheilanthes tenuifolia (Burm.f.) Swartz
Anogramma leptophylla (L.) Link
Adiantum aethiopicum L.

Aspleniaceae
Asplenium flabellifolium Cav.
A. praemorsum Swartz

Angiospermae

Scheuchzeriaceae
Triglochin centrocarpa Hook.

Gramineae
Aira caryophyllea L.
Poa caespitosa Forst.

Cyperaceae
Lepidosperma effusum Benth.

Centrolepidaceae
Brizula mucileri Hieron.
Centrolepis glabra (F. Muell) Hieron.

Philydraceae
Pritzelia pygmaea (R. Br.) F. Muell.

Liliaceae
Bulbine semibarbata (R. Br.) F. Muell.
Chamaescilla corymbosa (R. Br.) F. Muell.
Stypandra grandiflora Lindl.

Amaryllidaceae
Tribonanthes variabilis Lindl.
Hypoxis glabella R. Br.
H. occidentalis Benth.

Orchidaceae
Corybas dilatatus Rupp and Nicholls
Pterostylis nana R. Br.
Cryptostylis ovata R. Br.

Aizoaceae
Carpobrotus aequilaterus (Haw) N. E. Br.

Portulacaceae
Calandrinia pygmaea F. Muell.
C. calyptrata Hook.f.

Caryophyllaceae
Spergularia rubra (L.) J. and C. Presl

Droseraceae
Drosera glanduligera Lehm.

Crassulaceae
Crassula pedicellosa (F. Muell.) Ostenf.
C. macrantha (Hook.f.) Diels and Pritzel
C. sieberiana (Schultes) Druce

Pittosporaceae
Sollya fusiformis (Labill.) Briq.

Papilionaceae
Trifolium dubium Sibth.

Geraniaceae
Geranium pilosum Forst.
Pelargonium drummondii Turcz.

Oxalidaceae
Oxalis corniculata L.

Myrtaceae
Thryptomene saxicola (A. Cunn.) Schau.
Agonis juniperina Schau.
Darwinia citriodora (Endl.) Benth.

Umbelliferae
Hydrocotyle callicarpa Bunge
H. diantha D.C.
H. blepharocarpa F. Muell.
H. hirta R. Br.
Trachymene pilosa Sm.
T. anisocarpa (Turcz.) B. L. Burtt
Homalosciadium verticillatum (Turcz.) Domin

Primulaceae
Anagallis femina Mill.

Longaniaceae
Mitrasacme paradoxa R. Br.

Gentianaceae
Erythraea australis R. Br.
Villarsia calthifolia F. Muell.

Solanaceae
Solanum nigrum L.

Scrophulariaceae
Veronica calycina R. Br.
Bartsia latifolia Sibth. and Sm.

Lentibulariaceae
Polypompholyx tenella (R. Br.) Lehm.

Rubiaceae
Galium murale (L.) All.

Stylidiaceae
Levenhookia dubia Sond.
Stylidium corymbosum R. Br. var. *proliferum* Benth.
S. calcaratum R. Br.

Compositae
Helipterum cotula (Benth.) D.C.
Quinctia urvillei Cass.
Rutidosis multiflorus (Nees) B. L. Robinson
Angianthus tenellus (F. Muell.) Benth.
A. humifusus (Labill.) Benth.
Hypochoeris glabra L.
Cenia turbinata (L.) Pers.
Podolepis lessonii (Cass.) Benth.

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